VARIABLE SEAT BELT

TECHNICAL FIELD

[0001] This invention relates to vehicle seat belts that include a material that is configured to vary in size and shape in response to an activation signal.

BACKGROUND OF THE INVENTION

[0002] Prior art vehicles typically include seat belts. Seat belts in use in most passenger vehicles are three point seat belts, with webbing that forms a lap belt portion and a shoulder belt portion.

SUMMARY OF THE INVENTION

[0003] A seat belt system for use by an occupant of a vehicle seat is provided. The seat belt system includes seat belt webbing that has a solid material sufficiently configured to selectively effect a shape or dimensional change in the webbing in response to activation signals. The dimensional change may include an increase in webbing thickness so that the webbing acts as a pretensioner, reducing any gap that may exist between the belt and the occupant. The dimensional change may also result in an increased surface area in contact with the occupant. The solid material is preferably a shape memory material or a contractile polymer that exhibits abrupt volume changes in response to variations in external conditions, such as mechanical, chemical or electrical stimuli.

[0004] In an exemplary embodiment, the webbing includes a first segment and a second segment, each having a wide end and a narrow end. The first segment includes a buckle and the second segment includes a tongue member, and the first segment and the second segment are sufficiently configured so that when the buckle and the tongue member are engaged with one another, the webbing is positioned across the occupant

between the occupant's neck and the occupant's pelvis. The action of the webbing on the occupant is thus similar to hands holding an infant.

[0005] A method is also provided that includes monitoring a state or condition, and causing the size of seat belt webbing to change in response to a change in the monitored state or condition. Thus, the size of the seat belt is variable to accommodate, or compensate for, changes in vehicle conditions such as vehicle acceleration, occupant size, occupant position with respect to a vehicle seat, force exerted by an occupant against the seat belt webbing, etc.

[0006] The above features and advantages and other features and advantages of the present invention are readily apparent from the following detailed description of the best modes for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIGURE 1 is a schematic perspective view of a vehicle seat and a seat belt system;

[0008] FIGURE 2 is a schematic perspective view of the vehicle seat and seat belt of Figure 1 with the seat belt engaged across an occupant of the seat and in a contracted condition;

[0009] FIGURE 3 is a schematic cross sectional view of the seat belt in the contracted condition taken along a vertical plane;

[0010] FIGURE 4 is a schematic perspective view of the vehicle seat and seat belt with the seat belt in an expanded condition; and

[0011] FIGURE 5 is a schematic cross sectional view of the seat belt in the expanded condition taken along the same vertical plane as Figure 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Referring to Figure 1, a vehicle seat 10 includes a lower seat portion 14 and a seatback portion 18. A seat belt system 22 includes webbing 26. The webbing 26 includes a first segment 30A and a second segment 30B. Each segment 30A-B of webbing is tapered to include a wide end 34A, 34B and a narrow end 38A, 38B. Wide end 34A of segment 30A is mounted to one side of the seatback portion 18 by a track 42 so that segment 30A is selectively vertically adjustable. Similarly, wide end 34B of segment 30B is mounted to the other side of the seatback portion 18 by another track so that segment 30B is selectively vertically adjustable.

[0013] A buckle 44 is connected to the narrow end 38A of segment 30A, and a tongue member 48 is connected to the narrow end 38B of segment 30B. The tongue member 48 is releasably engageable with the buckle 44 to operatively connect the two webbing segments 30A, 30B. Referring to Figure 2, wherein like reference numbers refer to like components from Figure 1, the buckle 44 and the tongue member 48 are engaged so that the webbing 26 restrains an occupant 50 of the seat 10 by extending across the torso 51 of the occupant between, but not including, the occupant's neck 52 and pelvis 53. However, other seat belt configurations, such as a three-point or four-point seat belt configuration, may be used within the scope of the claimed invention. Seat belt retractors (not shown) in the seatback portion 18 may be employed to allow selective extension and retraction of segments 30A, 30B.

[0014] Referring to Figures 1 and 2, the segments 30A, 30B in the embodiment depicted are approximately the same length. The webbing 26 includes a plurality of ribs 58 comprised of a first material (shown at 60 in Figure 3) covered by an optional, protective, elastic second material (shown at 61 in Figure 3). Ribs 58 are spaced a distance apart from one another, and are interconnected by a third material 62 such as a polyester or nylon mesh. The first material 60 is sufficiently configured to selectively effect a shape or dimensional change in the webbing in response to activation signals. The webbing 26 is shown in a contracted condition in which the ribs 58 are characterized by a first size. Referring specifically to Figure 3, wherein like reference

numbers refer to like components from Figures 1 and 2, webbing 26 is characterized by thickness t_1 and height H_1. The webbing 26 is spaced a distance from the torso 51 of the occupant.

[0015] Referring again to Figure 2, a sensor 64 is configured to monitor at least one vehicle condition or characteristic, and transmit sensor signals 66 that describe, or are indicative of, the vehicle condition or characteristic. A controller 70 is configured to receive sensor signals 66. Controller 70 is programmed to analyze the sensor signals 66 according to a predetermined algorithm, and to selectively generate activation signals in response to the existence of at least one predetermined condition, as indicated by the sensor signals 66. In an exemplary embodiment, the sensor 64 is an accelerometer configured to monitor vehicle acceleration, and the predetermined condition is the vehicle acceleration being less than or equal to a predetermined negative value. However, those skilled in the art will recognize a variety of sensors and predetermined conditions that may be employed within the scope of the claimed invention.

[0016] Referring to Figure 4, sensor 64 transmits sensor signals 66' to controller 70 in response to the existence of the at least one predetermined condition. Controller 70 determines that the predetermined condition exists and, in response, the controller 70 causes the generation of activation signals 74 to which the first material is responsive to increase volume to a second size, with a corresponding change in webbing size and shape. The webbing 26 expands from the contracted condition to an expanded condition, as depicted in Figures 4 and 5. The webbing 26 in the expanded condition has a different size and shape from webbing in the contracted position, as shown in Figures 1-3.

[0017] With specific reference to Figure 5, the webbing 26 is characterized by thickness t_2, which is greater than thickness t_1. By increasing thickness, the webbing functions as a pretensioner, closing the distance between the webbing 26 and the torso 51 of occupant 50. The webbing 26 is characterized by height H_2, which is greater

than height H_1. By increasing in height, the webbing 26 provides increased surface area in contact with occupant torso 51. Ribs 58 are depicted having a circular cross section. However, the ribs and the first material 60 may, within the scope of the claimed invention, have any cross sectional shape. For example, it may be desirable for the first material 60 to have a square or rectangular cross section so that the webbing 26 presents a flat surface to the occupant's torso 51.

[0018] The first material 60 is depicted expanding radially. However, the material may also be configured to expand axially to effect a length change in the webbing 26 within the scope of the claimed invention. Furthermore, the interconnecting third material 62 is optional, and webbing may or may not be substantially entirely comprised of the first material within the scope of the claimed invention.

[0019] A sensor 78 on the webbing 26 is configured to transmit sensor signals 82 indicative of the size of occupant 50. More specifically, sensor 78 is configured to measure the force exerted on the webbing 26 by occupant 50, and transmit signals 82 indicative thereof to the controller. Referring again to Figure 4, the controller 70 is configured to modulate the activation signals 74 in response to the sensor signals indicative of the size of the occupant, so that the rate at which the shape or dimensional change in the webbing is effected is dependent on the size of the occupant 50. Those skilled in the art will recognize other sensors that may be employed to generate signals indicative of the size of an occupant that may be employed within the scope of the claimed invention. For example, a sensor in the lower seat portion 14 may measure the weight of the occupant 50. When the predetermined condition no longer exists, the controller 70 causes the cessation of activation signals 74, and the webbing returns to the contracted condition as depicted in Figures 1-3.

[0020] In the embodiment depicted, the first material 60 is a solid material in a form that enables the webbing to be flexible. For example, the first material 60 may be in the form of fibers or wires. In a preferred embodiment, the first material 60 is a

shape memory material that changes shape or size in response to an activation signal, such as a shape memory alloy. In another preferred embodiment, the first material 60 is a contractile polymer, such as artificial muscle fibers, which reversibly contracts and expands in response to chemical or electrical stimuli. Exemplary contractile polymers include polyaniline, polyacrylonitrile-polypyrrole (PAN-PPY), and polyvinylachohol (PVA) gel fibers. In the embodiment depicted, the stimulus is an electrical activation signal. Contractile polymers may also be characterized by abrupt volume changes in response to variations in external loading conditions. Advantageously, seat belt webbing comprising such a contractile polymer will contract with an equal and opposite response to a force exerted by an occupant against the webbing, with attendant pretensioning effects.

[0021] Alternatively, within the scope of the claimed invention, the ribs may be hollow, and configured for inflation with air or other fluids, in response to the controller transmitting an activation signal.

[0022] Referring again to Figure 4, the ribs 58 are depicted as having a substantially uniform diameter along the lengths of segments 30A and 30B. However, it may be desirable for the diameter of the ribs 58 to vary along the lengths of segments 30A, 30B so that the ribs have a greater diameter at the narrow ends 38A, 38B than at the narrow ends 34A, 34B. It should be noted that a webbing extension (not shown) may be employed between the buckle 44 and the tongue member 48 to provide increased seat belt length for larger occupants. The webbing extension may or may not change in size or shape in response to the activation signals.

[0023] While the best modes for carrying out the invention have been described in detail, those familiar with the art to which this invention relates will recognize various alternative designs and embodiments for practicing the invention within the scope of the appended claims.